# 3.10 PUBLIC HEALTH AND SAFETY (HAZARDOUS MATERIALS, FIRE MANAGEMENT AND EMF)

This section examines potential public health and safety impacts that could be associated with the Falcon to Gonder project, specifically, those related to hazardous materials, fire management, and electric and magnetic fields (EMF).

## 3.10.1 AREA OF ANALYSIS AND METHODOLOGY

The area of analysis is comprised of a 500-foot wide study corridor along the route alternatives (i.e., 250 feet on each side of the centerline). The methodology for analyzing impacts included identifying general types of hazardous materials and techniques that are likely to be used during project construction, operation, and maintenance. For fire management, activities and equipment that could pose fire hazards were evaluated. The methodology for evaluating EMF and electrical effects associated with operation of the 345 kV electric power facilities are described in detail in the following sections.

### REGULATORY FRAMEWORK

#### Fire Management Regulations

This project would be subject to state, county, and federally enforced laws, ordinances, rules, and regulations that pertain to prevention and suppression of fire activities.

#### Hazardous Materials Laws

Use, storage, and disposal of hazardous materials are regulated by numerous local, state, and federal laws. Existing laws that SPPC would be required to comply with for the Falcon to Gonder project include, but are not limited to, local emergency planning laws and programs; U.S. Department of Transportation regulations related to the transport of hazardous substances; the Resource Conservation and Recovery Act (RCRA); Toxic Substances Control Act; Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); Superfund Amendments and Reauthorization Act (SARA); Emergency Planning and Community Right-to-Know Act; Clean Water Act; Clear Air Act; BLM W.O. IM-93-344; and 40 CFR 260-302.

#### EMF and Transmission Line Electric Safety Guidelines and Regulations

Health and safety guidelines and regulations related to high-voltage transmission lines are provided in a number of sources, including the National Electrical Safety Code, American National Standards Institute, American Medical Association Council on Scientific Affairs, American Conference of Governmental Industrial Hygienists, various state regulations, and other organizations as discussed below.

## 3.10.2 AFFECTED ENVIRONMENT

### FIRE MANAGEMENT

The project would be located in a region susceptible to large-scale wildfires. In the summer of 1999, Nevada experienced one of the worst fire seasons since the 1940s. More than 1.5 million acres were burned. Figure 3.4-1 in Section 3.4, Vegetation, shows areas in the project area that were burned in 1999 and 2000. These locations were generally dominated by undisturbed native vegetation prior to the burn, as noted during vegetation surveys that were conducted for this project (SEI and Tetra Tech EMI 2000). However, native plant communities have become increasingly invaded by non-native vegetation, primarily cheatgrass (*Bromus tectorum*). Replacement of native vegetation by non-native vegetation, primarily cheatgrass, has been identified as a prime contributor to an increase in the frequency and severity of wildfires in the project area.

The movement of cheatgrass and other introduced species into Great Basin plant communities and the increased frequency and extent of wildfires have resulted in substantial economic and environmental harm, along with increased safety risks to people, wildlife, and domestic animals. For additional discussion of this issue, please see Section 3.4, Vegetation.

## HAZARDOUS MATERIALS

The project would be located in an area that is largely open space, public and private land used for grazing, mining, agriculture and recreational activities. The project area is very sparsely populated with only a few rural ranch houses, mobile homes, and trailers near the transmission line route alternatives that could potentially be exposed to hazardous materials associated with project construction and operation (see also Section 3.13, Land Use). The nearest towns are Ely, Eureka, and Crescent Valley.

## ELECTRIC AND MAGNETIC FIELDS

This section provides an overview of electric and magnetic fields (EMF) and describes some of the typical public health issues related to transmission lines. An evaluation of potential health and safety impacts from the proposed Falcon to Gonder transmission line follows.

### Electric Fields Overview

EMF is a term used to describe electric and magnetic fields that are created by electric voltage (electric field) and electric current (magnetic field). The potential or voltage (electrical pressure) on an object causes electric fields. Any object with an electric charge on it has a voltage (potential) at its surface, caused by the accumulation of more electrons on that surface as compared with another object or surface. The voltage effect is not limited to the surface of the object but exists in the space surrounding the object in diminishing intensity. Electric fields can exert a force on other electric charges at a distance. The change in voltage over distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). This unit is a measure of the difference in electrical potential or voltage that exists between two points one meter apart. The electric field becomes stronger near a charged object and decreases with distance away from the object.

Electric fields are a very common phenomenon. Static electric fields can result from friction generated when taking off a sweater or walking across a carpet. Body voltages have been measured as high as 16,000 volts due to walking on a carpet (Chakravarti 1976). The earth creates a natural static field in fair weather that is due to the 300,000 to 400,000 volt potential difference between the ionosphere and the surface of the earth (Veimeister 1972). At ground level, the mean value of the earth's electric field is approximately 120 V/m. This means that a 6-foot tall person would have a static potential of about 220 volts between the top and bottom of their body.

The normal fair weather static electric field of the earth varies from month to month, reaching a maximum of about 20% above normal in January, when the earth is closest to the sun, and falling to about 20% below normal by July, when the earth is farthest from the sun. Much stronger static electric potentials can exist underneath storm clouds, where the electric potential with respect to earth can reach 10 to 100 million volts (Veimeister 1972). Natural static electric fields under clouds and in dust storms can reach 3 to 10 kV/m (CRC 1981).

All household appliances and other devices that operate on electricity create electric fields. However, these fields are different from the earth's static or direct current (DC) field. Fields produced by electrical appliances that use alternating current (AC) reverse direction at a frequency of 60 cycles per second (60 Hertz, or Hz). The electric field in this case is caused by the changing electric voltage in the appliance. The magnitude of the electric field decreases rapidly with distance from the device. The field caused by point source (compact, small-dimension) household appliances generally attenuates more rapidly with distance than line source fields (such as from transmission lines). Appliances need not be in operation to create an electric field. Just plugging an appliance into an electrical outlet creates an electric field around it. Typical values of electric field measured one foot away from some common appliances are shown in Table 3.10-1.

**TABLE 3.10-1: TYPICAL ELECTRIC FIELD VALUES FOR APPLIANCES (AT 12 INCHES)**

| Appliance | Electric Field- kV/m |
|---|---|
| Electric Blanket | 0.25 * |
| Broiler | 0.13 |
| Stereo | 0.09 |
| Refrigerator | 0.06 |
| Iron | 0.06 |
| Hand Mixer | 0.05 |
| Phonograph | 0.04 |
| Coffee Pot | 0.03 |

** Note: 1 to 10 kV/m next to blanket wires*
*Source: Carstensen 1985, Enertech Consultants 1985*

## Transmission Lines

Electric power transmission lines create 60 Hz electric fields. These fields result from the voltage of the transmission line phase conductors with respect to the ground. Electric field strengths from a transmission line decrease with distance away from the outermost conductor, typically at a rate of approximately one divided by the distance squared ($1/d^2$). As an example, in an unperturbed field, if the electric field strength is 10 kV/m at a distance of one meter away, it would be approximately 2.5 kV/m at 2 meters away and 0.625 kV/m at 4 meters away. In contrast, the electric field strength from a single conductor typically decreases at a rate of approximately one divided by the distance ($1/d$). For example, an electric field strength of 10 kV/m at 1 meter away would decrease to approximately 5 kV/m at 2 meters away, and 2.5 kV/m at 4 meters away. Electric field strengths for a transmission line remain nearly constant over time because the voltage of the line is kept within bounds of about ±5% of its rated voltage. Transmission line electric fields are affected by the presence of grounded and conductive objects. Trees and buildings, for example, can significantly reduce ground level electric fields by shielding the area nearby (Deno 1987).

## Substations

Electric power substations also create electric fields due to voltage on station components. The equipment, or components of a substation, acts as point-sources of an electric field, similar to appliances in a home. As the distance from these point sources becomes greater than the physical size of the equipment acting as a source, the field is greatly reduced; this is also true for substation components, such as buswork. The electric fields of station equipment (transformers, circuit breakers, etc.) decrease external to a substation at a rate of approximately one divided by the distance cubed ($1/d^3$), unless an overhead transmission line is nearby. For example, a field of 10 kV/m at one meter away would be approximately 1.25 kV/m at 2 meters away, and 0.156 kV/m at 4 meters away. This contrasts with the linear or line-source characteristics of transmission lines that decrease as approximately one divided by the distance squared ($1/d^2$). Substation electric fields outside the fenced equipment area are typically very low because of shielding by metallic substation components themselves, as well as by the metal fencing surrounding the substation. Additional shielding is sometimes provided by nearby shrubbery and trees (Deno 1987).

## Magnetic Fields Overview

An electric current flowing in a conductor (electric equipment, household appliance, power circuits, etc.) creates a magnetic field. The most commonly used magnetic field intensity unit of measure is the gauss (G). For most practical applications, the gauss is too large, so a much smaller unit, the milligauss (mG), is used for reporting magnetic field magnitudes. The milligauss is one thousandth of a gauss. As a general reference, the earth has a natural static or DC magnetic field of about 0.540 gauss, or 540 mG, in central Nevada (Merrill 1983:20). As with electric fields, the magnetic fields from electric power facilities and appliances differ from static (or DC) fields because they are caused by the flow of 60 Hz alternating currents. Power frequency magnetic fields also reverse direction at a rate of 60 cycles per second, corresponding to the 60 Hz operating frequency of the power systems in the United States.

Since the magnetic field is caused by the flow of an electric current, a device must be operated to create a magnetic field. Magnetic field strengths of a large number of common household appliances were measured by the Illinois Institute of Technology Research (IITRI) for the U.S. Navy (Gauger 1985), and by Enertech Consultants for the Electric Power Research Institute (EPRI) (Silva 1989). Typical magnetic field values for some appliances are presented in Table 3.10-2 to facilitate a better understanding of magnetic field strength values.

**TABLE 3.10-2: MAGNETIC FIELDS FROM HOUSEHOLD APPLIANCES**

| MAGNETIC FIELD (MG) | | |
|---|---|---|
| **Appliance** | **12" Away** | **Maximum** |
| Electric Range | 3 to 30 | 100 to 1,200 |
| Electric Oven | 2 to 25 | 10 to 50 |
| Garbage Disposal | 10 to 20 | 850 to 1,250 |
| Refrigerator | 0.3 to 3 | 4 to 15 |
| Clothes Washer | 2 to 30 | 10 to 400 |
| Clothes Dryer | 1 to 3 | 3 to 80 |
| Coffee Maker | 0.8 to 1 | 15 to 250 |
| Toaster | 0.6 to 8 | 70 to 150 |
| Crock Pot | 0.8 to 1 | 15 to 80 |
| Iron | 1 to 3 | 90 to 300 |
| Can Opener | 35 to 250 | 10,000 to 20,000 |
| Mixer | 6 to 100 | 500 to 7,000 |
| Blender, Popper, Processor | 6 to 20 | 250 to 1,050 |
| Vacuum Cleaner | 20 to 200 | 2,000 to 8,000 |
| Portable Heater | 1 to 40 | 100 to 1,100 |
| Fans/Blowers | 0.4 to 40 | 20 to 300 |
| Hair Dryer | 1 to 70 | 60 to 20,000 |
| Electric Shaver | 1 to 100 | 150 to 15,000 |
| Color TV | 9 to 20 | 150 to 500 |
| Fluorescent Fixture | 2 to 40 | 140 to 2,000 |
| Fluorescent Desk | 6 to 20 | 400 to 3,500 |
| Circular Saws | 10 to 250 | 2,000 to 10,000 |
| Electric Drill | 25 to 35 | 4,000 to 8,000 |

There are many sources of magnetic fields encountered in everyday activities. Two major research projects have been done to estimate public exposure to ambient 60 Hz magnetic fields. This work was done to identify typical levels encountered by people inside homes and elsewhere. In the first study, a large number of residences located throughout the United States were measured to determine the sources and characteristics of residential magnetic fields (Enertech 1993). Table 3.10-3 summarizes the results of spot (point-in-time) magnetic field measurements made in the rooms of almost 1,000 residences. The average measured value for all rooms in this study was 0.9 mG.

Another comprehensive study of contemporary magnetic field exposure was recently performed for the U.S. Department of Energy (Enertech 1998). The objective of this work was to characterize personal magnetic field exposure of the general population. This was accomplished by randomly selecting over 1,000 people throughout the United States and recruiting these people to wear a recording magnetic field meter during a typical 24-hour period, including all activity inside and away from the place of residence (Silva 1999). The study population was selected in a manner to be representative of the general population. The measurement population (both genders) included about 874 adults and 138 children. The U.S. 24-hour average for all people in this study was 1.25 mG. Tables 3.10-4 and 3.10-5 summarize results for fractions of the U.S population that exceed selected magnetic field levels and the exposure levels measured for different occupations.

### TABLE 3.10-3: SUMMARY OF SPOT ROOM MEASUREMENTS IN THE UNITED STATES (992 RESIDENCES)- MG

| Values Exceeded in: | ALL ROOMS | | | | |
|---|---|---|---|---|---|
| | Median | Average | Kitchen | Bedroom(s) | Highest Room * |
| 50 % of residences | 0.5 | 0.6 | 0.7 | 0.5 | 1.1 |
| 25 % of Residences | 1.0 | 1.1 | 1.2 | 1.0 | 2.1 |
| 10 % of Residences | 1.7 | 2.1 | 2.4 | 2.0 | 3.8 |
| 5 % of Residences | 2.6 | 3.0 | 3.5 | 2.9 | 5.6 |
| 1 % of Residences | 5.8 | 6.6 | 6.4 | 7.7 | 12.2 |

** Any room in which spot field measurement had the highest value*

### TABLE 3.10-4: PERCENTAGE OF U.S. POPULATION WITH AVERAGE FIELD EXPOSURE EXCEEDING GIVEN VALUES

| 24-Hr Field | Est. Portion | 95% Confidence Interval | Population Range |
|---|---|---|---|
| > 0.5 mG | 76.3% | 73.8 % - 78.9 % | 197 - 211 million |
| > 1 mG | 43.6% | 41 % - 46.5 % | 109 - 124 million |
| > 2 mG | 14.3% | 11.9 % - 17.2 % | 31.8 - 45.9 million |
| > 3 mG | 6.3% | 4.8 % - 8.3 % | 12.8 - 22.2 million |
| > 4 mG | 3.35% | 2.4 % - 4.7 % | 6.4 - 12.5 million |
| > 5 mG | 2.42% | 1.67 % - 3.52 % | 4.5 - 9.4 million |
| > 10 mG | 0.43% | 0.21 % - 0.90 % | 0.56 - 2.4 million |
| > 15 mG | 0.1% | 0.02 % - 0.55 % | 50 thousand - 1.5 million |

**TABLE 3.10-5: AVERAGE MAGNETIC FIELD EXPOSURE DURING WORK FOR DIFFERENT OCCUPATIONS**

| Occupation | n | Avg. Field At Work |
|---|---|---|
| Managerial, professional, specialty | 204 | 1.64 mG |
| Technical, sales, administrative, support | 166 | 1.58 mG |
| Service: Protective, food, health, cleaning | 71 | 2.74 mG |
| Farming, forestry, fishing | 19 | 0.91 mG |
| Precision production, craft, repair, operators, fabricators, laborers | 128 | 1.73 mG |
| Electrical | 16 | 2.15 mG |

## Transmission Lines

60 Hz transmission line magnetic fields are generated by the current flowing on the phase conductors. Similar to the electric field, field strengths decrease with distance away from the line. Unlike electric fields that vary little over time, magnetic fields are not constant over time because the current on any transmission line changes in response to increasing and decreasing electrical load.

## Substations

Electric power substations also create magnetic fields due to current flow on station components. Because a substation is a collection of components that can each be a magnetic field source, a substation complex is often treated as a single point-source for external field measurements taken at a distance. External magnetic fields associated with the substation (e.g., the collection of equipment or components) can be considered separately from the magnetic fields associated with the transmission lines that serve the substation. The manner in which substation component magnetic fields attenuate with distance is similar to that of appliances, where the field strengths diminish rapidly as the distance from the source grows larger than the dimensions of the source itself (for example, a transformer). Therefore, at distances on the order of 50 feet or more from the substation fence, the external magnetic field would have decreased to a much lower level than the level inside the substation. In contrast to electric fields, the substation magnetic fields are not affected significantly (shielded) by most common objects.

## Induced Currents

Electric currents can be induced by electric and magnetic fields in conductive objects near to transmission lines. For magnetic fields, the concern is for very long objects parallel and close to the line. The majority of concern is about the potential for small electric currents to be induced by electric fields in metallic objects close to transmission lines. Metallic roofs, vehicles, vineyard trellises, and fences are examples of objects that can develop a small electric charge in proximity to high voltage transmission lines. Object characteristics, degree of grounding, and electric field strength affect the amount of induced charge. An electric current can flow when an object has an induced charge and a path to ground is presented. The amount of current flow is determined by the impedance of the object to ground and the voltage induced between the object and ground. The amount of induced current that can flow is important to evaluate because of the potential for nuisance shocks to people and the possibility of other effects, such as fuel ignition.

The amount of induced current can be used to evaluate the potential for harmful or other effects. Previous work on appliance leakage current can provide some insight into this issue. Leakage (and induced) current is commonly measured in units of milliamperes, mA (i.e., one mA is 0.001 amperes of electric current). Most appliances have a leakage current that flows through the body of the user.

Usually, the amount of current is very small and is below the threshold of perception. Many factors affect how much current flows. In addition to appliance design and age, contact resistance and insulation from ground affect the magnitude of current that flows through the user.

Appliance leakage currents have been measured for a variety of appliances, with levels ranging from 0.002 mA to tens of mA (Kahn 1966, Stevenson 1973). There is a U.S. standard for the leakage current from appliances that was developed to minimize the potential for electric shock hazards and sudden involuntary movements that might result in an accident (ANSI 1992). The standard limits appliance leakage current to 0.5 mA for portable appliances and 0.75 mA for stationary or fixed appliances. The standard was developed with consideration of the variable threshold of human perception of electric current.

Different people and different situations produce a range of current perception values. As an example, when an average person grips an energized conductor, the median (50-percentile) threshold for perception of an AC electric current is 0.7 mA for women and 1.1 mA for men (Dalziel 1972, EPRI 1982). If the current is gradually increased beyond a person's perception threshold, it becomes bothersome, and possibly startling. With sufficiently large currents, the muscles of the hand and arm involuntarily contract and a person cannot release the gripped object. The reasonably safe value at which 99.5% can let-go (0.5% cannot) is 9 mA for men and 6 mA for women (Bridges 1985:10). An equivalent let-go value of 5 mA has been estimated for children (EPRI 1982:377).

However, before the current flows in a shock situation, contact must be made, and in the process of establishing contact a small arc occurs. This causes a withdrawal reaction that, in some cases, may be a hazard if the involuntary nature of the reaction causes a fall or other accident. Consideration of let-go currents was the basis for the National Electric Safety Code (NESC) to set an induced current limit of 5 mA for objects under transmission lines (ANSI 1996:72-73).

## HUMAN HEALTH STUDIES

Over the past two decades or so, there has been significant concern over the potential for exposure to EMF to adversely affect human health. There have been a variety of health concerns that included a variety of diseases and other health endpoints, such as reproductive outcome. The possible effect of EMF on human health was originally focused on electric fields, but much of the recent research has focused on magnetic fields. Some of the initial concern was raised by studies done in Denver that reported a positive association between cancer incidence and homes that were near certain transmission line configurations that were thought to produce high levels of magnetic fields (Wertheimer 1979, 1981). Since then, much research has been done to evaluate the potential for EMF exposure to affect human health.

Some of these studies have generally found no conclusive evidence of harmful effects from typical transmission line and substation electric and magnetic fields. However, some studies during this period did report the potential for harmful effects to humans. Complicating resolution of this issue is the lack of knowledge as to what characteristics of electric and magnetic field exposure (if any) need to be considered to assess human exposure effects. The exposure most often considered is intensity or magnitude of the field. There is a consensus among the medical and scientific communities that there is insufficient evidence to conclude that EMF causes adverse health effects. Neither the medical nor scientific communities have been able to provide any foundation upon which federal or state regulatory bodies could establish a standard or limit for exposure that is known to be either safe or harmful.

There is a large body of EMF health literature. Perhaps the best way to evaluate the potential for EMF exposure to affect human health is to consider some of the extensive scientific literature reviews of the extant research conducted by independent reviewer committees. The Oak Ridge Associated Universities (ORAU) established a panel, at the request of the Committee on Interagency Radiation Research and Policy Coordination, to perform an independent scientific review and evaluate the reported health hazards of exposure to extremely low frequency electric and magnetic fields. The panel reviewed about 1,000 journal articles published within the last 15 years. The ORAU panel completed their EMF literature review and published a report (ORAU 1992).

In the conclusions to the report, the authors state (ORAU 1992: VIII-10-10-11-11):

> This review indicates that there is no convincing evidence in the published literature to support the contention that exposures to extremely low-frequency electric and magnetic fields (ELF-EMF) generated by sources such as household appliances, video display terminals, and local power lines are demonstrable health hazards.

It says later in the report:

> Although exposure to ELF-EMF does not appear to constitute a public health problem, there is evidence that these fields may produce some biological effects, such as changes in the pattern of secretion of the hormone melatonin and enhancement of healing of bone fractures. These findings and those described elsewhere in this report suggest areas of some scientific interest and warrant consideration for further research.

The report concludes with:

> This review does not provide justification for a major expansion of the national research effort to investigate the health effects of ELF-EMF. In the broad scope of research needs in basic science and health research, any health concerns over exposures to ELF-EMF should not receive a high priority.

## American Medical Association (AMA)

The AMA adopted recommendations of its Council on Scientific Affairs (CSA) regarding EMF health effects. The report was prepared as a result of a resolution passed at the 1993 annual meeting. The following statements were adopted and are based on the CSA's review of EMF epidemiologic and laboratory studies to date, as well as on several major literature reviews (AMA 1994:12):

- That no scientifically documented health risk has been associated with the usually occurring levels of electromagnetic fields; nevertheless, the American Medical Association (AMA) should continue to monitor developments and issues related to the subject.
- That the AMA should encourage research efforts sponsored by agencies such as the National Institutes of Health, the U.S. Department of Energy, and the National Science Foundation to continue on exposures to electromagnetic fields and their effects, average public exposures, occupational exposures, and the effects of field surges and harmonics.
- That the AMA should support the meeting of an authoritative, multidisciplinary committee under the auspices of the National Academy of Sciences or the National Council on Radiation Protection and Measurements to make recommendations about exposure levels of the public and workers to electromagnetic fields and radiation.

## American Cancer Society

In the journal, *A Cancer Journal for Clinicians*, the American Cancer Society (ACS) reviewed EMF residential and occupational epidemiologic research in an article written by Dr. Clark W. Heath, Jr., ACS's vice president of epidemiology and surveillance research. Dr. Heath reviews 13 residential epidemiologic studies of adult and childhood cancer and reported the following (ACS 1996:42):

> The weakness and inconsistent nature of epidemiologic data, combined with the continued dearth of coherent and reproducible findings from experimental laboratory research, leave one uncertain and rather doubtful that any real biological link exists between EMF exposure and carcinogenicity.

## National Institute of Environmental Health Sciences

The federal government has recently completed a $60 million EMF research program managed by the National Institute of Environmental Health Sciences (NIEHS) and the U.S. Department of Energy (DOE). This comprehensive EMF research program was called EMF RAPID (Research and Public Information Dissemination) Program. At the conclusion of this major effort, the NIEHS submitted a report to the U.S. Congress on their findings (NIEHS 1999).

Among other things, the NIEHS concluded that:

> The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm. (NIEHS 1999:36).

The NIEHS report also included the following conclusions:

> Epidemiological studies have serious limitations in their ability to demonstrate a cause and effect relationship whereas laboratory studies, by design, can clearly show that cause and effect are possible. Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done in cells fail to support a causal relationship between exposure to ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings. (NIEHS 1999:ii).
>
> The NIEHS agrees that the associations reported for childhood leukemia and adult chronic lymphocytic leukemia cannot be dismissed easily as random or negative findings. The lack of positive findings in animals or in mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but cannot completely discount the finding. The NIEHS also agrees with the conclusion that no other cancers or non-cancer health outcomes provide sufficient evidence of a risk to warrant concern. (NIEHS 1999:36).
>
> The National Toxicology Program routinely examines environmental exposures to determine the degree to which they constitute a human cancer risk and produces the 'Report on Carcinogens' listing agents that are 'known human carcinogens' or 'reasonably anticipated to be human carcinogens.' It is our opinion that based on evidence to date, ELF-EMF exposure would not be listed in the 'Report on Carcinogens' as an agent 'reasonably anticipated to be a human carcinogen.' This is based on the limited epidemiological evidence and the findings from the EMF-RAPID Program that did not indicate an effect of ELF-EMF exposure in experimental animals or a mechanistic basis for carcinogenicity. (NIEHS 1999:37).
>
> The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards. We also encourage technologies that lower exposures from neighborhood distribution lines provided that they do not increase other risks, such as those from accidental electrocution or fire. (NIEHS 1999:37-38).

## ELECTRIC AND MAGNETIC FIELD STANDARDS

### EMF Standards

A number of states have set some type of electric or magnetic field limit. In addition, other organizations have established field exposure standards or guidelines. Existing EMF guidelines or limits are summarized in Tables 3.10-6 through 3.10-8.

### Corona Effects

One phenomenon associated with all energized electrical devices, including high-voltage transmission lines, is corona. Under certain conditions, the localized electric field near an energized conductor can be sufficiently concentrated to ionize air close to the conductors (EPRI 1982:169). This can result in a partial discharge of electrical energy called a corona discharge, or corona. Several factors, including conductor voltage, shape and diameter, and surface irregularities such as scratches, nicks, dust, or water drops, can affect a conductor's electrical surface gradient and its corona performance.

Corona is the physical manifestation of energy loss and can transform discharge energy into very small amounts of sound, radio frequency noise, heat, and chemical reactions of the air components. Corona activity on 345 kV transmission lines in foul weather conditions can produce very tiny amounts of visible light. This light is very difficult to see, but on dark rainy nights it may be occasionally observed close to the line. There are no standards for visible light from transmission lines. This is because the amount of light produced by corona activity is insignificant. The intensity of light is very dim and is not enough to illuminate the landscape.

**TABLE 3.10-6: STATE REGULATIONS FOR TRANSMISSION LINE FIELDS**

| State | Field Limit |
|---|---|
| Montana | 1 kV/m at edge of right-of-way (in residential areas) |
| Minnesota | 8 kV/m maximum on right-of-way |
| New Jersey | 3 kV/m at edge of right-of-way |
| New York | 1.6 kV/m at edge of right-of-way |
| | 200 mG at edge of right-of-way |
| North Dakota | 9 kV/m maximum on right-of-way |
| Oregon | 9 kV/m maximum on right-of-way |
| Florida | 10 kV/m for 500 kV Lines- maximum on right-of-way |
| | 2 kV/m for 500 kV Lines- at edge of right-of-way |
| | 8 kV/m for 230 kV and smaller Lines- maximum on right-of-way |
| | 2 kV/m for 230 kV and smaller Lines- at edge of right-of-way |
| | 200 mG for 500 kV Lines- at edge of right-of-way |
| | 250 mG for double circuit 500 kV Lines- at edge of right-of-way |
| | 150 mG for 230 kV and smaller Lines- at edge of right-of-way |

*Source: OTA 1989*

**TABLE 3.10-7: AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS OCCUPATIONAL THRESHOLD LIMIT VALUES FOR 60-HZ EMF**

| Electric Field | Magnetic Field |
|---|---|
| **Occupational exposures should not exceed :** | **Occupational exposures should not exceed :** |
| 25 kV/m<br>(from 0 Hz to 100 Hz) | 10 G<br>(10,000 mG) |
| *Prudence dictates the use of protective devices (e.g. suits, gloves, insulation) in fields above 15 kV/m.* | |
| *For workers with cardiac pacemakers or similar medical electronic devices, maintain exposure at or below 1 kV/m (1,000 V/m).* | *For workers with cardiac pacemakers or similar medical electronic devices, maintain exposure at or below 1 G (1,000 mG).* |

*Source: ACGIH 1999*

**TABLE 3.10-8: INTERNATIONAL COMMISSION ON NON-IONIZING RADIATION PROTECTION (ICNIRP)**

| Exposure (60 Hz) | Electric Field | Magnetic Field |
|---|---|---|
| **Occupational :** | | |
| Reference Levels for Time-Varying Fields | 8.333 kV/m (8,333 V/m) | 4.167 G (4,167 mG) |
| Current Density for Head and Body | 10 mA/m² (25 kV/m) | 10 mA/m² (5 G) |
| **General Public :** | | |
| Reference Levels for Time-Varying Fields | 4.167 kV/m (4,167 V/m) | 0.833 G (833 mG) |
| Current Density for Head and Body | 2 mA/m² (5 kV/m) | 2 mA/m² (1 G) |

*Source: ICNIRP 1998*

## 3.10.3 ENVIRONMENTAL CONSEQUENCES

The following sections analyze potential health and safety impacts associated with fire management, hazardous materials, and electric and magnetic fields (EMF).

### SIGNIFICANCE CRITERIA

Project construction and operation activities would have a significant impact to public health and safety if they would:

- Create a new fire hazard.
- Involve the use of disposal of hazardous materials that pose a substantial hazard to people or the environment.
- Interfere with adopted emergency response plans or emergency evacuation plans.
- Create a substantial public health hazard.

## ENVIRONMENTAL IMPACTS – COMPARISON OF ALTERNATIVES

### Impacts Common to All Route Alternatives

The following section identifies potential public health and safety impacts that would be common to all of the route alternatives (i.e., they would occur with any of the route alternatives).

#### Fire Management

- ***Impact Health and Safety-1: Potential Fire Hazards Related to Construction, Operation and Maintenance***

Construction, operation, and maintenance of the project could increase the potential for a fire in the project area. Workers smoking, sparks from equipment, or other activities could start a fire. The potential for fire hazards is considered a significant impact that could be mitigated to less-than-significant by implementation of the following mitigation measures.

- ***Mitigation Measure Health and Safety-1***

In addition to Mitigation Measures Vegetation-1 and -4, Invasive Weeds-1, and actions outlined in the Reclamation Plan in Appendix E, SPPC would implement a Fire Prevention and Suppression Plan during construction, operation, and maintenance of the proposed transmission line. While a detailed plan should be prepared as part of the COM Plan, a preliminary outline of the plan is provided in Appendix F, Preliminary Fire Prevention and Suppression Plan, describing some of the basic practices and techniques that should be used to minimize fire hazards associated with the project.

- ***Impact Public Health and Safety-2: Potential Fire Hazard from Energized Transmission Line***

When the transmission line is energized, it could potentially cause a fire hazard if a conducting object were to come into proximity to the transmission line, resulting in a flashover to ground, or if an energized phase conductor were to fall to the earth and remain in contact with combustible material long enough to heat this material and cause a fire. The mechanical and structural design, selection of materials, and construction of transmission lines takes into account normal and unusual structural loads, such as ice and wind, which could cause the phase conductors to break. It is theoretically possible that an energized phase conductor could cause a fire if it were to fall to the ground and create an electrical arc that can ignite combustible material; however, this is a very unlikely event. If, for some reason, an energized phase conductor does fall to the ground and create a line-ground fault, high-speed relay equipment is designed to sense that condition and actuate circuit breakers that can de-energize the line in less than about one-tenth of a second. This procedure has proven to be a reliable safety measure and reduces the risk of fire from high voltage transmission lines to a low level.

Furthermore, SPPC would construct the line to comply with minimum ground clearances set forth in the National Electrical Safety Code and would clear trees and tall objects under the transmission line over the life of the project to provide adequate distance from objects below the line.

If a vehicle were refueled under a high-voltage transmission line, a possible safety concern could be the potential for accidental fuel ignition. The source of fuel ignition could be a spark discharge into fuel vapors collected in the filling tube near the top of the gas tank. The spark discharge would be due to current induced in a vehicle (insulated from ground) by the electric field of the transmission line and discharged to ground through a metallic refueling container held by a well-grounded person.

Theoretical calculations show that if a number of unlikely conditions exist simultaneously, a spark could release enough energy to ignite gasoline vapors (EPRI 1982: 381). This could not occur if a vehicle were simply driven or parked under a transmission line. Rather, several specific conditions would need to be satisfied: A large gasoline-powered vehicle would have to be parked in an electric field of about 5 kV/m or greater (Deno 1985). A person would have to be refueling the vehicle while standing on damp earth and while the vehicle is on insulating dry asphalt or gravel. The fuel vapors and air would have to mix in an optimum proportion. Finally, the pouring spout must be metallic. The chances of having all the conditions necessary for fuel ignition present at the same time are extremely small. Very large vehicles (necessary to collect larger amounts of electric charge) are often diesel-powered, and diesel fuel is less volatile and more difficult to ignite. The proposed 345 kV transmission line electric field levels are too low (about 1.1-4.5 kV/m on the right-of-way) for the minimum energy necessary for fuel ignition under any practical circumstances.

An additional consideration would be gasoline stations located near the right-of-way edge. The low electric fields of the transmission line would be further reduced to almost zero due to shielding by typical metallic coverings over the refueling area and by the presence of any nearby light poles or trees (Deno 1987). A typical tractor-trailer gasoline truck used to replenish the underground fuel storage tanks is commonly grounded during fuel handling operations, and this is done to eliminate electric discharges. Therefore, fuel ignition does not pose a significant hazard.

SPPC also would outline its standard fire monitoring and emergency response procedures in the COM Plan, including protocols for notifying local fire protection agencies. Thus, fire hazards from the transmission line would be considered adverse but not significant.

❑ ***Impact Health and Safety-3: Potential Fire Hazards Related to Cheatgrass***

The invasion of cheatgrass and consequential increased wildfire frequency is a natural phenomenon that is occurring throughout the Great Basin. However, cheatgrass invasion can be accelerated in areas with ground disturbances, as discussed in Sections 3.4, Vegetation and 3.5, Invasive Nonnative Species. Vegetation disturbance related to project construction has the potential to contribute to increases in cheatgrass cover and extent, which could lead to increased wildfire frequency and fire damage. However, this potentially significant impact would be mitigated to less-than-significant through implementation of Mitigation Measures Vegetation-1 and Invasive Weeds-1 and the Reclamation Plan in Appendix E.

### Hazardous Materials

Use of hazardous materials during project construction, operation, and maintenance would pose potential health and safety hazards to construction and maintenance workers and nearby residents. These impacts would be associated with blasting during tower installation, use of hazardous substances during construction and maintenance activities, and the potential for spills. The following list displays hazardous materials that are typically used for SPPC transmission line projects (Aspen 1995).

- 2-cycle oil (contains distillates and hydrotreated heavy paraffinic)
- ABC fire extinguisher
- Acetylene gas
- Air tool oil
- Ammonium hydroxide
- Automatic transmission fluid
- Battery acid (in vehicles and in the meter house of the substations)
- Bee Bop Insect Killer
- Canned spray paint
- Chain lubricant (contains methylene chloride)
- Connector grease (penotox)
- Contact cleaner 2000
- Diesel de-icer
- Diesel fuel additive
- Explosives (detonators, detonator assemblies – non-electric, tubular primers, cap-type primers, ammonium nitrate fertilizers)
- Eye glass cleaner (contains methylene chloride)
- Gasoline

- Gasoline treatment
- Hot Stick Cleaner (cloth treated with polydimethylsiloxane)
- Insulating oil (inhibited, non-PCB)
- Lubricating grease
- Mastic coating
- Methyl alcohol
- North wasp and hornet spray (1,1,1-trichloroethene)
- Oxygen
- Paint thinner
- Petroleum products (gasoline, diesel fuel, jet fuel A, lubricants, brake fluid, hydraulic fluid)
- Prestone 11 Antifreeze
- Propane
- Puncture Seal Tire Inflator
- Safety Fuses
- Starter Fluid
- Sulfur Hexaflouride (within the circuit breakers in the substations)
- Wagner Brake Fluid
- WD-40
- ZEP (safety solvent)
- ZIP (1,1,1-Tricholorethane)

Use, storage, and disposal of hazardous materials are regulated by numerous local, state, and federal laws. Existing laws that SPPC would be required to comply with for the Falcon to Gonder project include, but are not limited to, local emergency planning laws and programs; U.S. Department of Transportation regulations related to the transport of hazardous substances; the Resource Conservation and Recovery Act, Toxic Substances Control Act; Comprehensive Environmental Response; Compensation and Liability Act; Superfund Amendments and Reauthorization Act; Emergency Planning and Community Right-to-Know Act; Clean Water Act; Clear Air Act; BLM W.O. IM-93-344; and 40 CFR 260-302.

Detailed information about the use, storage and disposal of hazardous materials will be provided in the Construction, Operation and Maintenance (COM) Plan that would be submitted to BLM. This Plan will define specific procedures for vehicle refueling and servicing, transportation and storage of hazardous materials, and disposal of hazardous wastes. For example, construction vehicles and equipment would be required to be serviced and fueled at least 100 feet from wetlands and streams. Refueling locations should be generally flat to decrease the chance of a spilled substance reaching a stream or wetland.

Procedures would be outlined to minimize the chance of a fuel spill during servicing and refueling. Vehicles would be required to carry absorbent material to handle potential spills, would be inspected for fuel leaks regularly, and would be equipped with fire fighting equipment. Hazardous materials would be transported in Department of Transportation (DOT) approved containers and allowed only on approved access roads. Vehicles carrying hazardous materials would be equipped with appropriate materials to contain a small spill should one occur during transport. Vehicles and storage containers would be properly signed/marked and inspected for leakage and other potential safety problems prior to transportation.

Hazardous materials would be stored in proper containers in material yards and designated construction areas. Cleanup materials will be stored in these areas. Hazardous wastes, including used oil, used oil filters, used gasoline containers, spent batteries, and other items, would be collected regularly and disposed of in accordance with all applicable laws. Every effort should be made to minimize the production of hazardous waste during the project, such as using non-hazardous substances when available, minimizing the amount of hazardous materials used for the project, and recycling and filtering hazardous materials.

Under existing law, SPPC would be required to maintain Material Safety Data Sheets and a Department of Transportation (DOT) Emergency Response Guidebook at material yards, construction sites, substations, and in construction and maintenance crew vehicles. SPPC also would be required to complete an SF 299 Section 19 Hazardous Materials List and prepare and submit for approval a Blasting Plan and a Spill Prevention and Control Plan (in addition to the Fire Prevention and Suppression Plan noted above). These plans, along with the DOT Emergency Response Guidebook, would adequately control the use, production, transportation, and storage of hazardous materials along the transmission line corridor, access roads, material yards, and substations. In addition, SPPC is prohibited by law from treating or disposing of any hazardous materials outside of an approved treatment or disposal site. Proper implementation of the COM Plan would be expected to result in less-than-significant impacts from hazardous materials.

The Fire Prevention and Suppression Plan, Spill Prevention and Control Plan, and Blasting Plan would be included in the COM Plan, as well. Also, as part of its standard operating procedures, SPPC would develop a health and safety plan with procedures for emergencies and coordination with local hospitals and public safety officials. The transmission line would not block use of paved roadways, and thus, is not expected to interfere with adopted emergency response plans or emergency evacuation plans.

❑ ***Impact Health and Safety-4: Potential Health and Safety Impacts from Hazardous Materials***

Use of hazardous materials during project construction, operation, and maintenance would pose potential health and safety hazards to construction and maintenance workers and nearby residents. These impacts would be associated with blasting during tower installation, use of hazardous substances during construction and maintenance activities, and the potential for spills. However, compliance with existing laws regulating the use, storage, transportation and disposal of hazardous materials, and the preparation and implementation of the Fire Prevention and Suppression, Spill Prevention and Control, and Blasting Plans in the COM Plan, would minimize these public health and safety hazards. Therefore, potential health and safety impacts from use, storage, and disposal of hazardous materials would be less-than-significant.

### Electric and Magnetic Fields

This following section evaluates electrical effects associated with operation of the high-voltage electric power facilities proposed for the Falcon to Gonder project. These electrical effects include corona and field effects. EMF is generally described and project levels are calculated. Power frequency EMF is a natural consequence of electrical circuits and can be either directly measured with proper instruments, or calculated using appropriate information. The potential effects of EMF are discussed along with other considerations, such as induced currents, fires, and computer interference.

#### *Facility Description*

The Falcon to Gonder transmission line is proposed to be built as a single circuit 345,000-volt (345 kV) AC line with twin 954 kcm ACSR conductors per phase and two 3/8 inch EHS steel overhead shieldwires. The transmission line would be supported by approximately 725 to 820 tubular steel H-frame structures that would vary in height from 75 to 130 feet above ground level, depending on terrain. The 345 kV transmission line right-of-way width would be 160 feet. The H-frame tower structure helps discourage attempts by unauthorized people to climb the towers. At some locations, the 345 kV line may parallel existing rights-of-way for lower voltage transmission lines (25 kV, 66 kV, 120 kV, and 230 kV).

The transmission line would be parallel to existing transmission lines in some locations (e.g., Segments A, B, E, I, and J), and stand alone in other locations. To analyze EMFs that would be generated by the project, three different transmission line configurations were selected as representative examples:

1. The proposed 345 kV line alone.
2. The proposed 345 kV line paralleling existing 66/25 kV and 120 kV transmission lines.
3. The proposed 345 kV line paralleling an existing 230 kV transmission line.

Figures 3.10-1, 3.10-2 & 3.10-3 present diagrams of each respective transmission line configuration.

The project also includes the installation of additional facilities at the existing Falcon and Gonder substations. The Falcon 345/120 kV substation would have new switching equipment installed, including a terminal bay, buswork, and three 345 kV power circuit breakers and two 345 kV reactors to control voltage. One reactor would be a fixed reactor continuously connected to the line. The second reactor would be a switched reactor utilized during light loading conditions or during line switching. The existing Falcon substation pad and fenced area would be expanded approximately 3 acres to the south and east. The Gonder 230/69 kV substation (owned and operated by Mt. Wheeler Power) would be upgraded to 345 kV. New 230 kV buswork would be required to connect to the existing 230 kV ring bus. New equipment includes two 230 kV power circuit breakers, two 345/230 kV- 300 MVA transformers, two 345 kV power circuit breakers, and two 345 kV reactors to control voltage. The substation pad and fenced area would require an approximate 6.2-acre expansion to the north.

### *Electric Fields*

*Methodology*

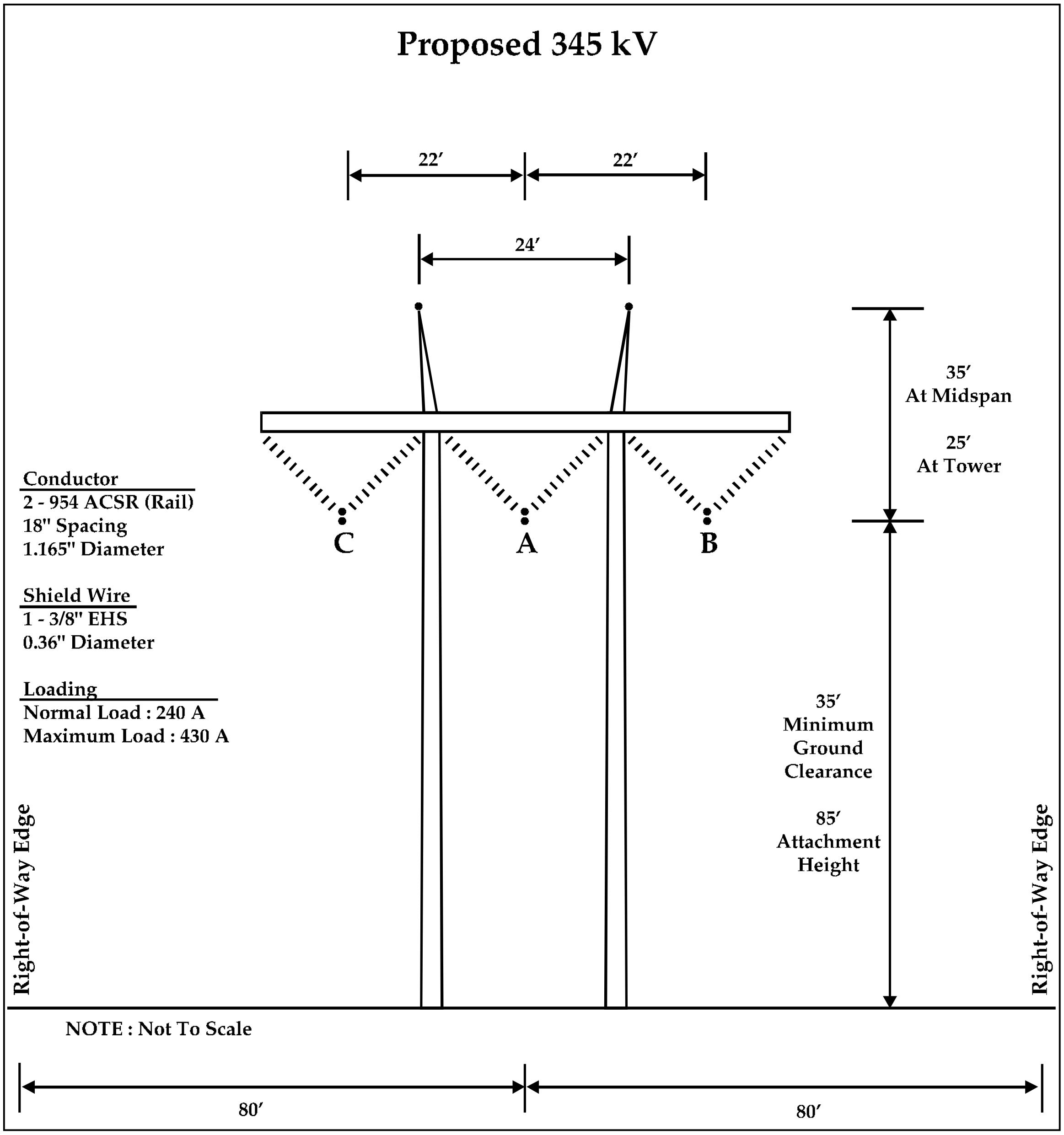
In cases where a transmission line is proposed to be constructed, electric field values can be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program to create a model of the proposed line. The software then calculates the power frequency electric field at locations of interest. Results obtained with computer models have been compared with measurement data for operating transmission lines and calculation accuracy has been evaluated. Typically, the computer model would calculate electric field values to within +/- 5% of actual field measurements.

A computer program originally developed by the Bonneville Power Administration was used to perform the field calculations (BPA 1977). Ground clearances and span lengths can vary throughout the length of each of the transmission line segments due to the irregular terrain. Since these elevation variations are present in the project area, the minimum conductor ground clearance was assumed for each transmission line modeled.

Angle structures were not specifically modeled in the calculations for the following reasons: electric fields values in most cases would not be significantly greater than the values calculated for other structures modeled (this is because the strongest fields usually occur away from the angle structure near the mid-span of the transmission line), and angle structures make up a small percentage of the line. Therefore, only straight segments of the transmission line were modeled.

Certain assumptions were made to generate a reasonable worst-case scenario for electric field calculation purposes. These assumptions included: a 5% over-voltage condition; all minimum ground clearances occur simultaneously for each configuration; and currents were balanced and had a phasing of A = 0 degrees, B = 240 degrees, and C = 120 degrees. It is important in these calculations to properly and consistently designate the phase relationship of the conductors. In modern electrical systems, power is generated by three-phase generators. Each phase is connected to one conductor of the transmission line and called Phase A, Phase B, or Phase C. This designation is followed through the entire system from generator to substation. Because the system operates with all generators in synchronism, currents in Phase A are displaced in time from currents in Phases B and C. By convention, SPPC has designated Phase A equal to 0 degrees, Phase B equal to 240 degrees, and Phase C equal to 120 degrees. These values are essential to the calculations and are part of the assumptions made here.

**FIGURE 3.10-1: CONFIGURATION #1: PROPOSED 345 KV TRANSMISSION LINE ALONE**



## FIGURE 3.10-2: CONFIGURATION #2: PROPOSED 345 KV TRANSMISSION LINE PARALLELING EXISTING 66/25 KV AND 120 KV TRANSMISSION LINES

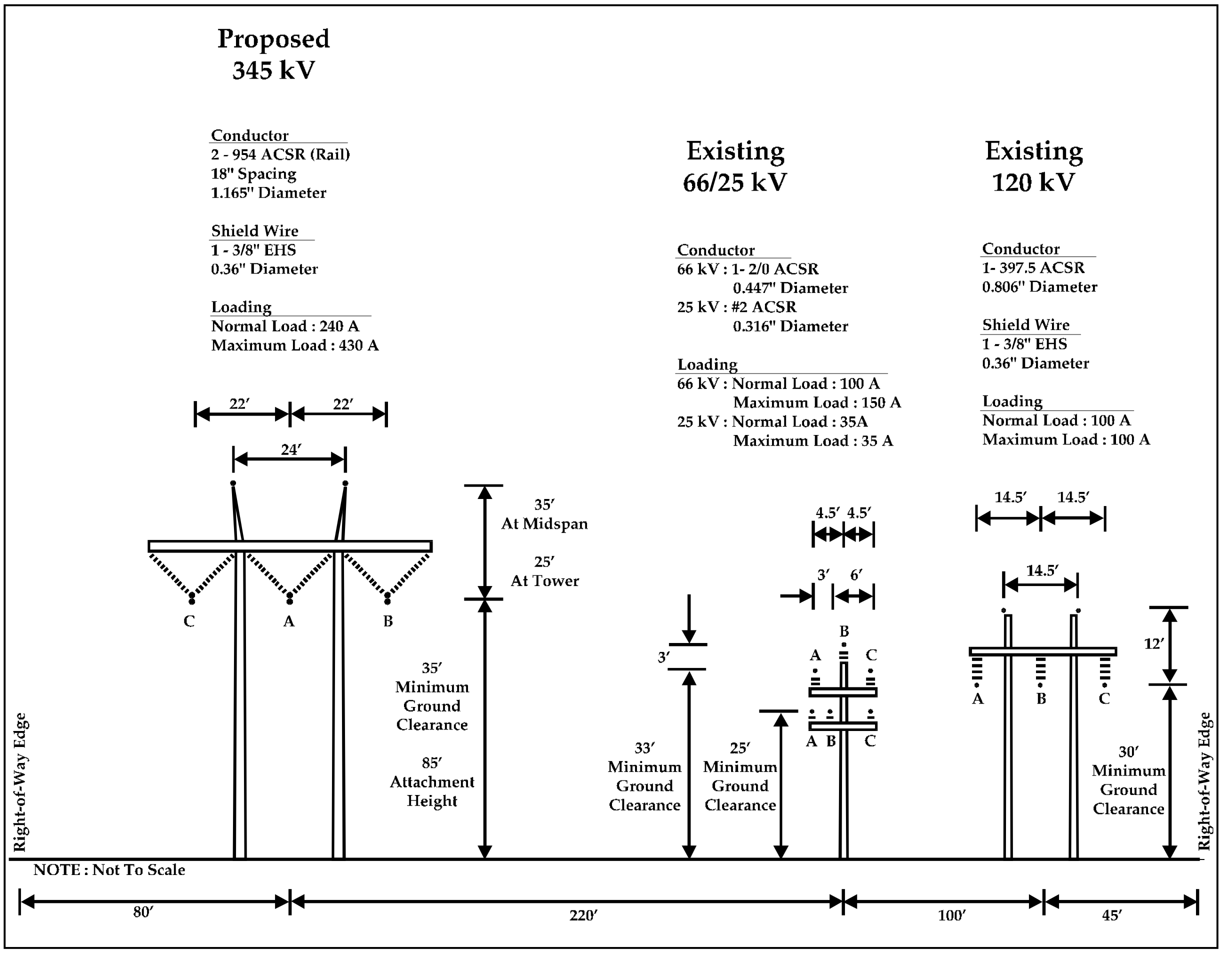
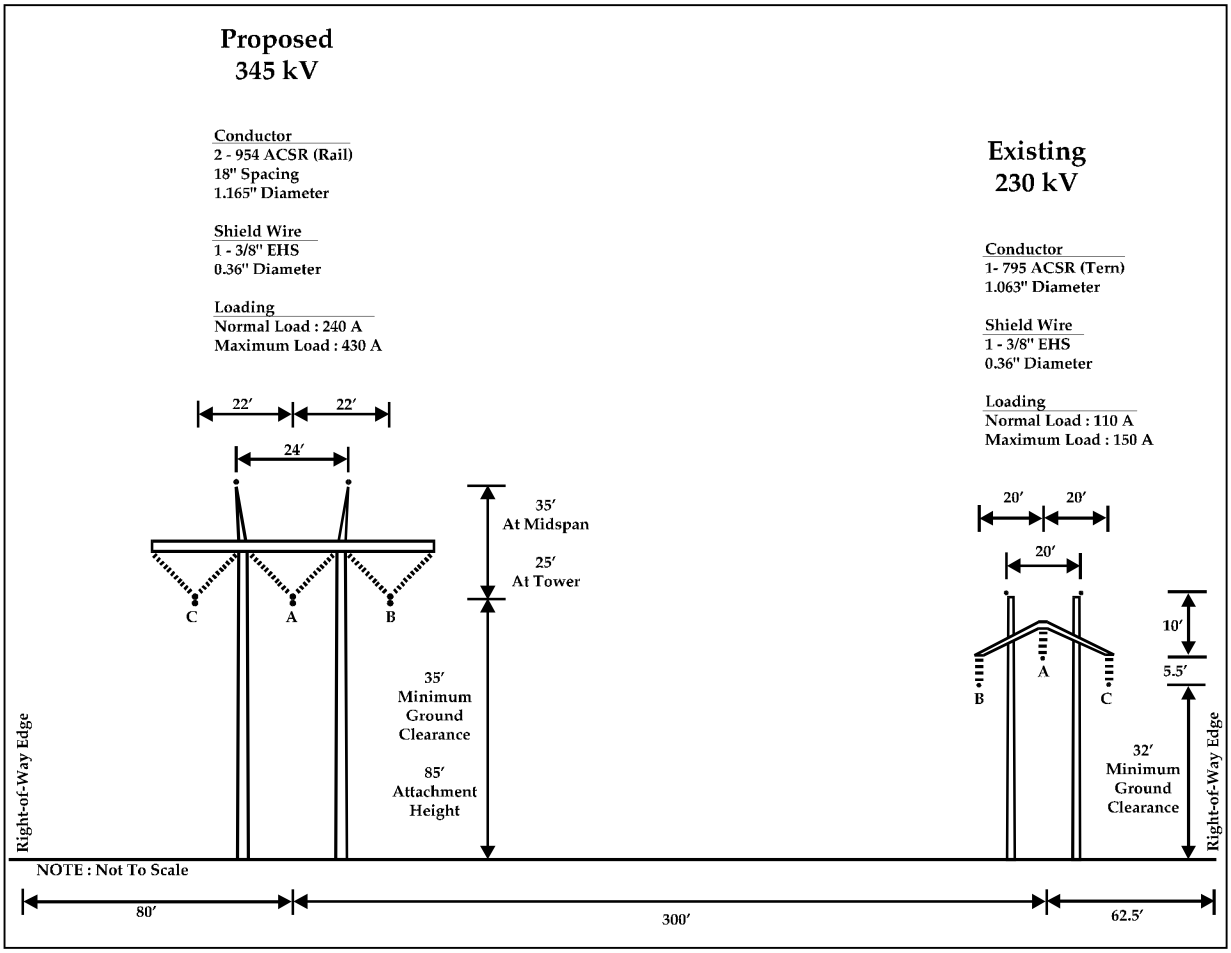


**FIGURE 3.10-3: CONFIGURATION #3: PROPOSED 345 KV TRANSMISSION LINE PARALLELING EXISTING 230 KV TRANSMISSION LINE**

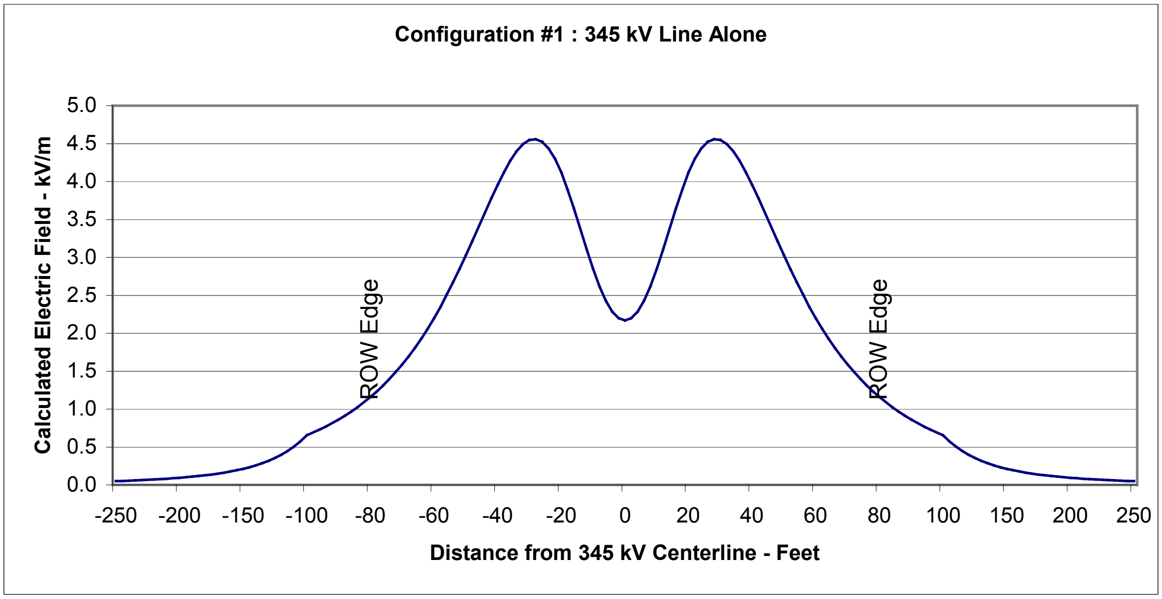



*Transmission Line – Estimated Project Effects*

The electric field values were calculated for each of the three sample transmission line configurations: (1) the proposed 345 kV line alone, (2) the proposed 345 kV line paralleling an existing 66/25 kV and 120 kV transmission line right-of-way (ROW), and (3) the proposed 345 kV line paralleling an existing 230 kV transmission line ROW. Lateral profiles were calculated for the electric field (a lateral profile is a plot of the calculated maximum field as a function of distance away from the ROW center). All electric field calculations were made at the IEEE standard of 1 meter above ground level and at transmission line midspan.

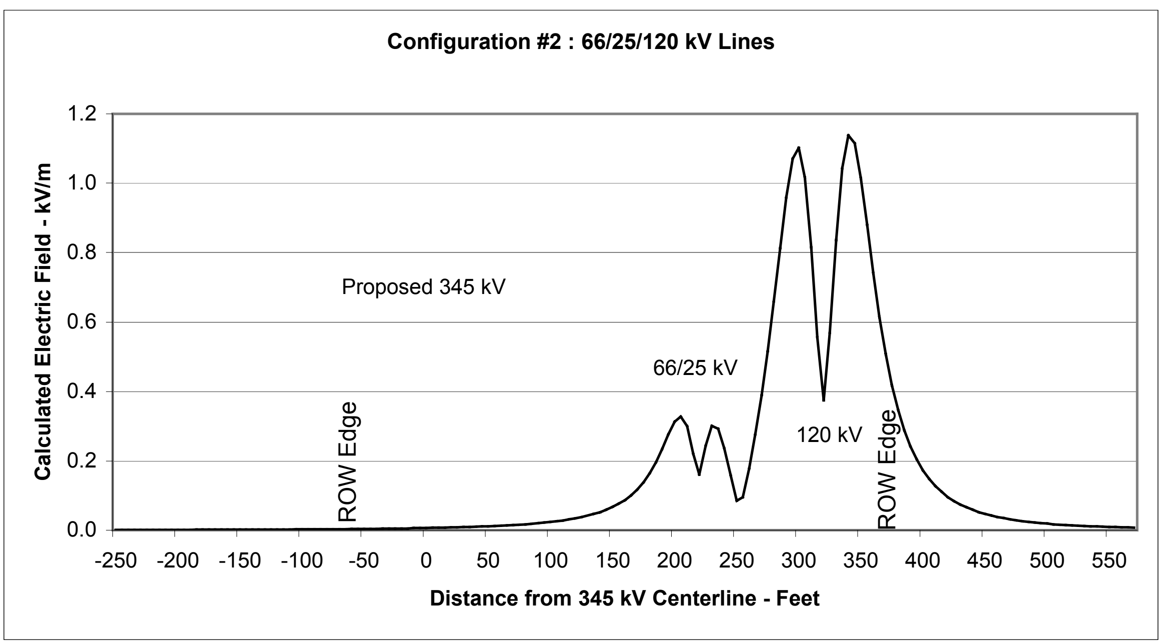
An electric field graph showing the lateral profile of the calculated field extending away from the proposed 345 kV H-frame configuration is shown in Figure 3.10-4. The calculated electric field is about 1.159 kV/m along each side of the right-of-way edge, with a maximum field of about 4.559 kV/m on the right-of-way. These calculated electric field levels would be an increase over an ambient condition of 0.0 kV/m for those locations where no other existing electrical facilities are present.

**FIGURE 3.10-4: CALCULATED ELECTRIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE ALONE**

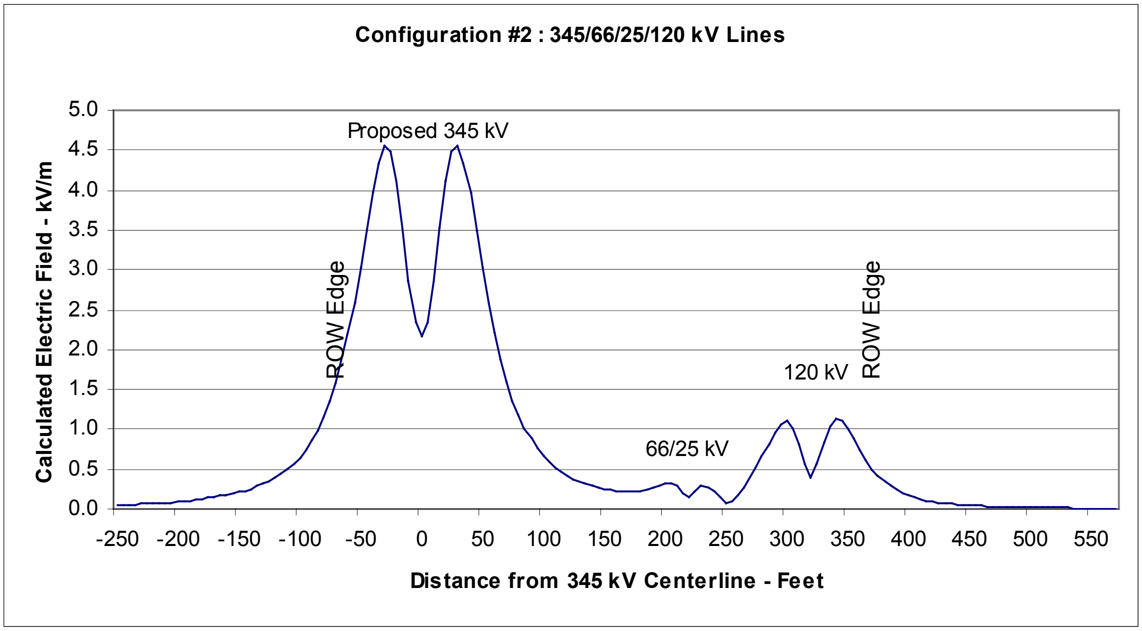



Electric field lateral profiles were also calculated for the proposed 345 kV with a 66/25 kV and 120 kV transmission lines. Figure 3.10-5 presents the calculated electric field for the existing condition, with only the 66/25 kV and 120 kV transmission lines present. Electric field calculations with the addition of the proposed Falcon to Gonder 345 kV transmission line are presented in Figure 3.10-6. With this proposed configuration, the calculated electric field is about 1.158 kV/m along the right-of-way edge closest to the proposed 345 kV transmission line. Under the 345 kV line, the maximum calculated electric field is about 4.547 kV/m. The electric field decreases to about 0.200 to 0.300 kV/m near the 66/25 kV line, increases to about 1.138 kV/m under the 120 kV transmission line, and then decreases to about 0.614 kV/m at the right-of-way edge closest to the 120 kV transmission line.

**FIGURE 3.10-5: CALCULATED ELECTRIC FIELD PROFILE FOR THE EXISTING 66/25 KV AND 120 KV TRANSMISSION LINES**



### FIGURE 3.10-6: CALCULATED ELECTRIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE PARALLELING THE EXISTING 66/25 KV AND 120 KV TRANSMISSION LINES




Electric field lateral profiles were also calculated for the proposed 345 kV parallel to a 230 kV transmission line. Figure 3.10-7 presents the calculated electric field for the existing condition, with only the 230 kV transmission line present. Electric field calculations with the addition of the proposed Falcon to Gonder 345 kV transmission line are presented in Figure 3.10-8. With this configuration, the calculated electric field is 1.157 kV/m along the right-of-way edge closest to the proposed 345 kV transmission line. Under the 345 kV line, the maximum calculated electric field is about 4.555 kV/m. The electric field decreases to about 0.270 kV/m between the lines, increases to about 2.524 kV/m near the 230 kV transmission line, and then decreases to about 0.879 kV/m at the right-of-way edge closest to the 230 kV transmission line.

### FIGURE 3.10-7: CALCULATED ELECTRIC FIELD PROFILE FOR THE EXISTING 230 KV TRANSMISSION LINE

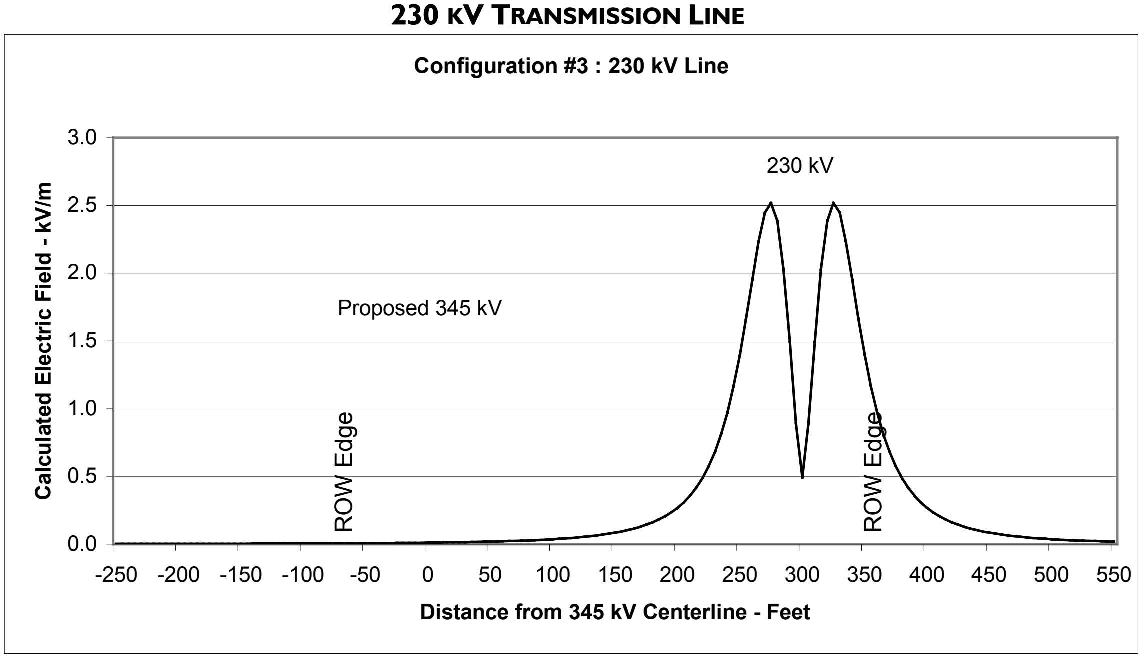


**FIGURE 3.10-8: CALCULATED ELECTRIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE PARALLELING EXISTING 230 KV TRANSMISSION LINE**

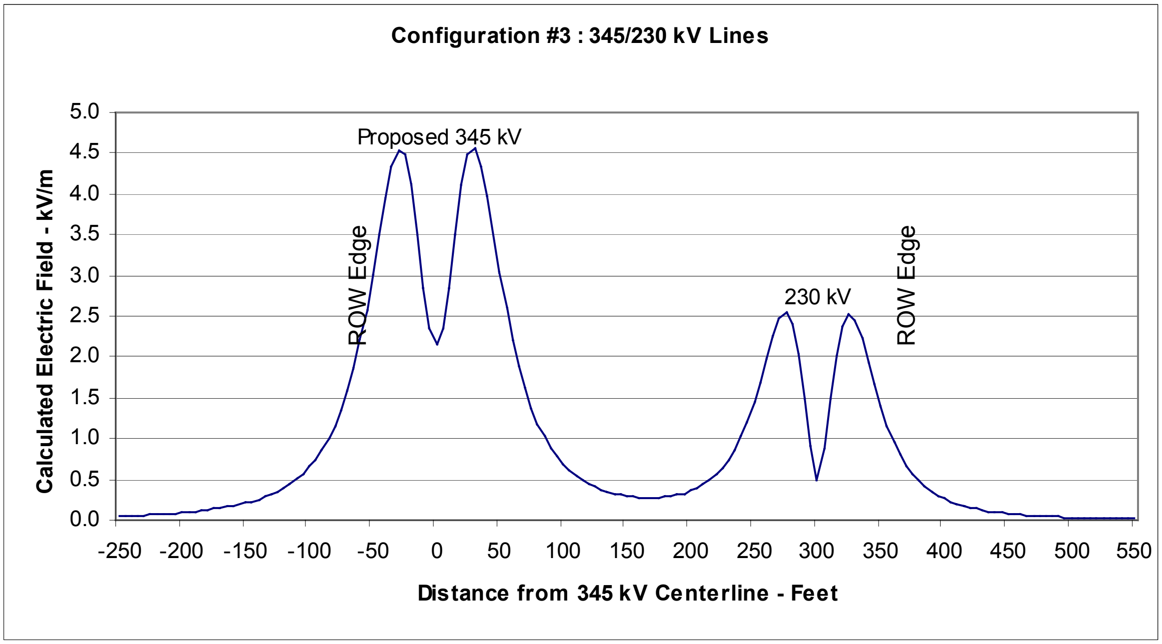



Table 3.10-9 summarizes the electric field calculations for the three transmission line configurations.

**TABLE 3.10-9: SUMMARY OF ELECTRIC FIELD CALCULATIONS FOR THE THREE TRANSMISSION LINE CONFIGURATIONS**

| CALCULATED ELECTRIC FIELD – KV/M | | | | | | | |
|---|---|---|---|---|---|---|---|
| Configuration Type | ROW Edge | Maximum on ROW | ROW Edge | Max Near 345 kV | Max Near 66/25 kV | Max Near 120 kV | Max Near 230 kV |
| #1 : 345 kV Alone | 1.159 | 4.559 | 1.159 | 4.559 | | | |
| #2 : 345 kV with 66/25/120 kV Lines | 1.159 | 4.547 | 0.614 | 4.547 | 0.300 | 1.138 | |
| #3 : 345 kV with 230 kV Line | 1.157 | 4.555 | 0.879 | 4.555 | | | 2.524 |

*Substation – Estimated Project Effects*

The electric field from substation equipment and buswork are typically shielded by the surrounding equipment, supporting structures, substation fence, and other nearby objects. The dominant sources of electric fields near a substation are typically the overhead electrical transmission lines that enter and exit the substation. For the Falcon to Gonder 345 kV project, the addition of new transformers, buswork, reactors, circuit breakers, and other internal electrical equipment should not significantly impact electric field levels outside of the substation. The dominant source of increased electric fields near the substation would be due to the proposed 345 kV transmission line itself.

***Magnetic Fields***

*Methodology*

Magnetic field values can also be calculated using computer modeling software. These programs allow the transmission line configuration information and other parameters to be entered into the program to create a model of the proposed line. The software then calculates the power frequency magnetic field at locations of interest. Results obtained with computer models have been compared with measurement data for operating transmission lines, and calculation accuracy has been evaluated. Typically, the computer model would calculate magnetic field values to within +/- 5% of actual field measurements.

A computer program originally developed by the Bonneville Power Administration was used to perform the field calculations (BPA 1977). Ground clearances and span lengths can vary throughout the length of each of the transmission line segments due to the irregular terrain. Since these elevation variations are present in the project area, the minimum conductor ground clearance was assumed for each transmission line modeled.

Angle structures were not specifically modeled in the calculations for the following reasons: magnetic fields values, in most cases, would not be significantly greater than the values calculated for other structures modeled (this is because the strongest fields usually occur away from the angle structure near the mid span of the transmission line), and angle structures make up a small percentage of the line. Therefore, only straight segments of the transmission line were modeled.

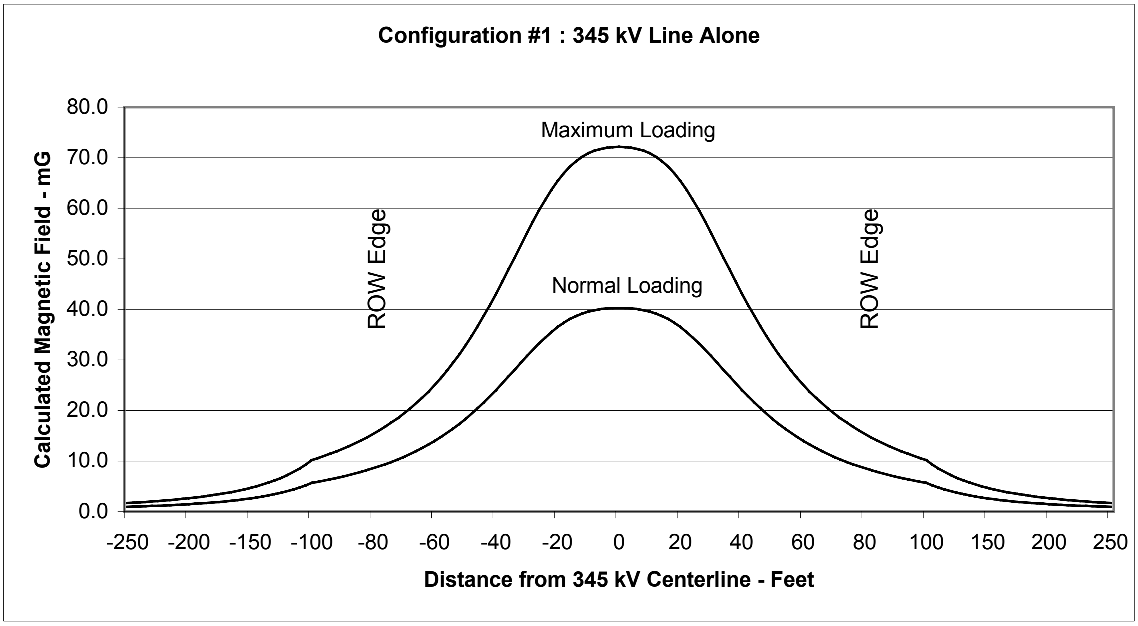
Certain assumptions were made to generate a reasonable worst case scenario for magnetic field calculation purposes. These assumptions included: all minimum ground clearances occur simultaneously for each configuration; and currents were balanced and had a phasing of A = 0 degrees, B = 240 degrees, and C = 120 degrees. It is important in these calculations to properly and consistently designate the phase relationship of the conductors. In modern electrical systems, power is generated by three-phase generators. Each phase is connected to one conductor of the transmission line and called Phase A, Phase B, or Phase C. This designation is followed through the entire system from generator to substation. Because the system operates with all generators in synchronism, currents in Phase A are displaced in time from currents in Phases B and C. By convention, SPPC has designated Phase A equal to 0 degrees, Phase B equal to 240 degrees, and Phase C equal to 120 degrees. These values are essential to the calculations and are part of the assumptions made here. The direction of current flow for all of the transmission lines was assumed to be in the same direction.

*Transmission Line – Estimated Project Effects*

The magnetic field values were calculated for each of the three sample transmission line configurations. Lateral profiles were calculated for the magnetic field (a lateral profile is a plot of the calculated maximum field as a function of distance away from the ROW center). All magnetic field calculations were made at the IEEE standard of 1 meter above ground level and at transmission line mid-span.

A magnetic field graph showing the lateral profile of the calculated field extending away from the proposed 345 kV H-frame configuration is shown in Figure 3.10-9 for both normal and maximum loading conditions (240 A and 430 A, respectively). Under normal loading conditions, the calculated magnetic field is about 8.6 mG along each side of the right-of-way edge, with a maximum field of about 40.3 mG on the right-of-way. Under maximum loading conditions, the calculated magnetic field is about 15.4 mG along each side of the right-of-way edge, with a maximum field of about 72.1 mG on the right-of-way. These calculated magnetic field levels would be an increase over an ambient condition of 0.0 mG for those locations where no other existing electrical facilities or other sources of electric current are present.

**FIGURE 3.10-9: CALCULATED MAGNETIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE ALONE**




Magnetic field lateral profiles were also calculated for the proposed 345 kV parallel to a 66/25 kV and 120 kV transmission lines. Figure 3.10-10 presents the calculated magnetic field for the existing condition, with only the 66/25 kV and 120 kV transmission lines present. Magnetic field calculations with the addition of the proposed Falcon to Gonder 345 kV transmission line are presented in Figure 3.10-11.

**FIGURE 3.10-10: CALCULATED MAGNETIC FIELD PROFILE FOR THE EXISTING 66/25 KV AND 120 KV TRANSMISSION LINES**

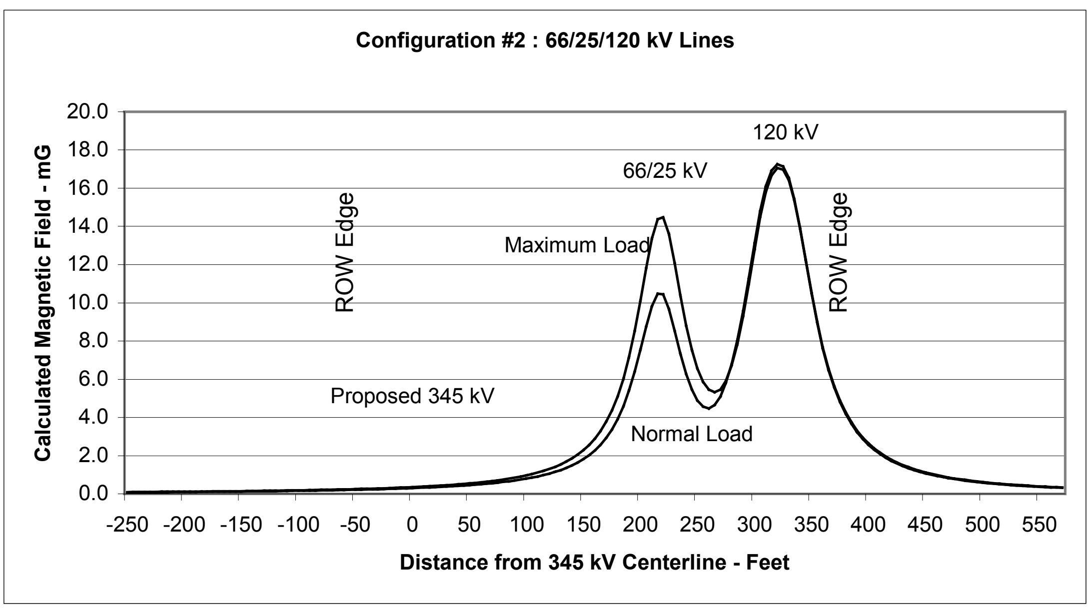
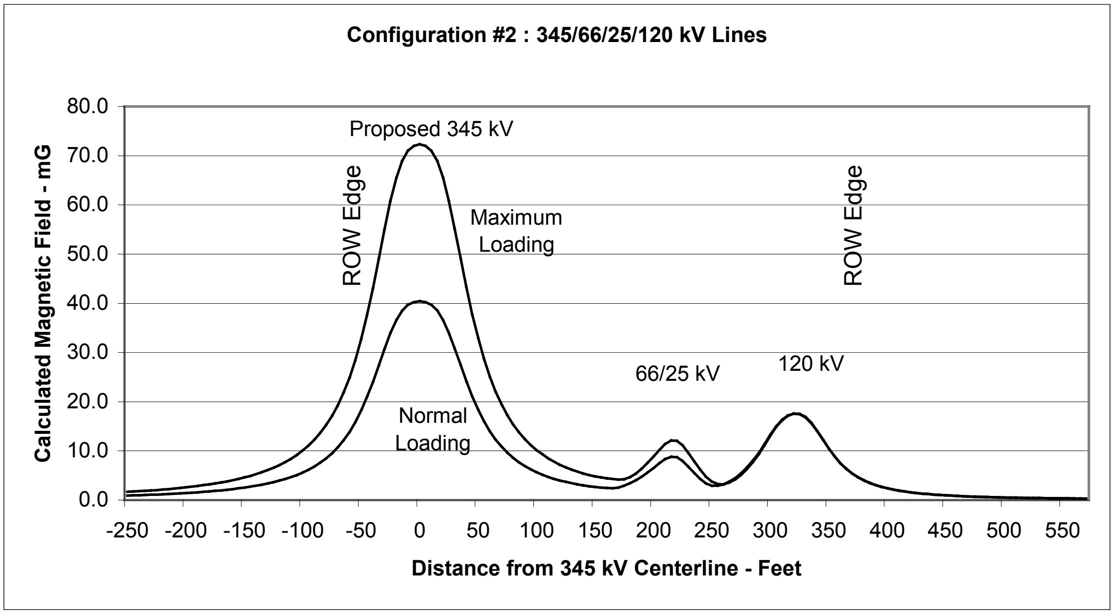


**FIGURE 3.10-11: CALCULATED MAGNETIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE PARALLELING EXISTING 66/25 KV AND 120 KV TRANSMISSION LINES**




With this configuration under normal loading conditions, the calculated magnetic field is about 8.5 mG along the right-of-way edge closest to the proposed 345 kV transmission line. Under the 345 kV line, the maximum calculated magnetic field is about 40.4 mG. The magnetic field decreases to about 8.8 mG near the 66/25 kV line, increases to about 17.6 mG under the 120 kV transmission line, and then decreases to about 6.9 mG at the right-of-way edge closest to the 120 kV transmission line. For maximum loading conditions, the calculated magnetic field is about 15.2 mG at the right-of-way edge, 72.3 mG under the 345 kV line, 12.1 mG under the 66/25 kV line, 17.6 mG under the 120 kV line, and 6.9 mG at the right-of-way edge.

Magnetic field lateral profiles were also calculated for the proposed 345 kV transmission line parallel to a 230 kV line. Figure 3.10-12 presents the calculated magnetic field for the existing condition, with only the 230 kV transmission line present. Magnetic field calculations with the addition of the proposed Falcon to Gonder 345 kV transmission line are presented in Figure 3.10-13. With this configuration under normal loading conditions, the calculated magnetic field is again 8.4 mG along the right-of-way edge closest to the proposed 345 kV transmission line. Under the 345 kV line, the maximum calculated magnetic field is about 40.5 mG. The magnetic field decreases to about 1.4 mG between the lines, increases to about 21.1 mG near the 230 kV transmission line, and then decreases to about 5.3 mG at the right-of-way edge closest to the 230 kV transmission line. Under maximum loading conditions, the calculated magnetic field is about 15.2 mG at the right-of-way edge, 72.5 mG under the 345 kV line, 29.0 mG under the 230 kV line, and 7.2 mG at the right-of-way edge.

**FIGURE 3.10-12: CALCULATED MAGNETIC FIELD PROFILE FOR THE EXISTING 230 KV TRANSMISSION LINE**

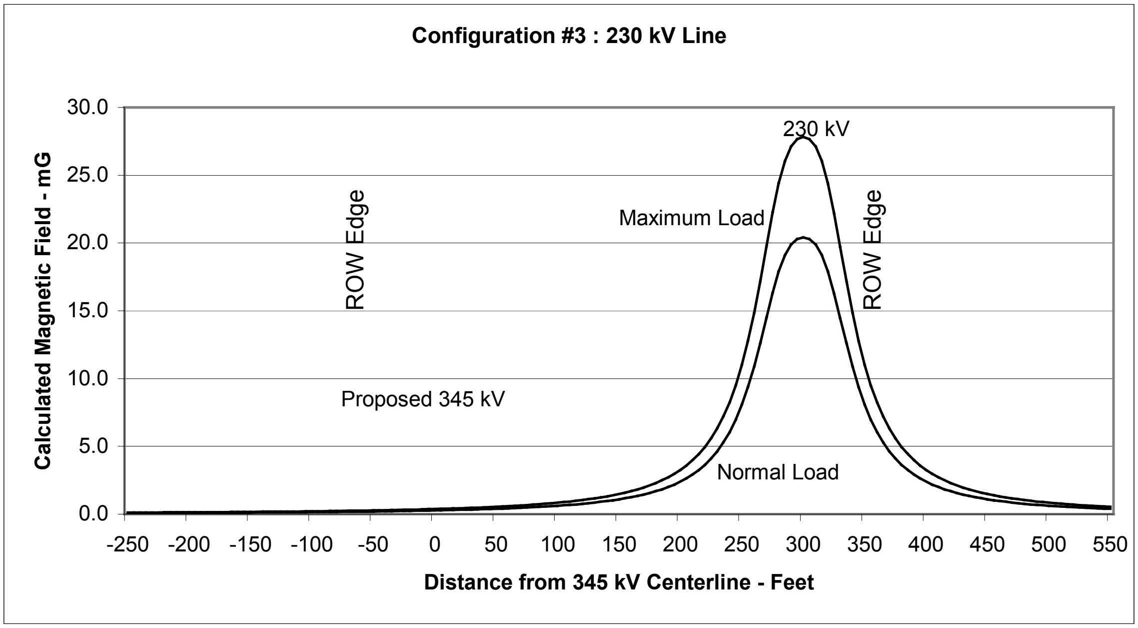



**FIGURE 3.10-13: CALCULATED MAGNETIC FIELD PROFILE FOR THE PROPOSED 345 KV TRANSMISSION LINE PARALLELING EXISTING 230 KV TRANSMISSION LINE**

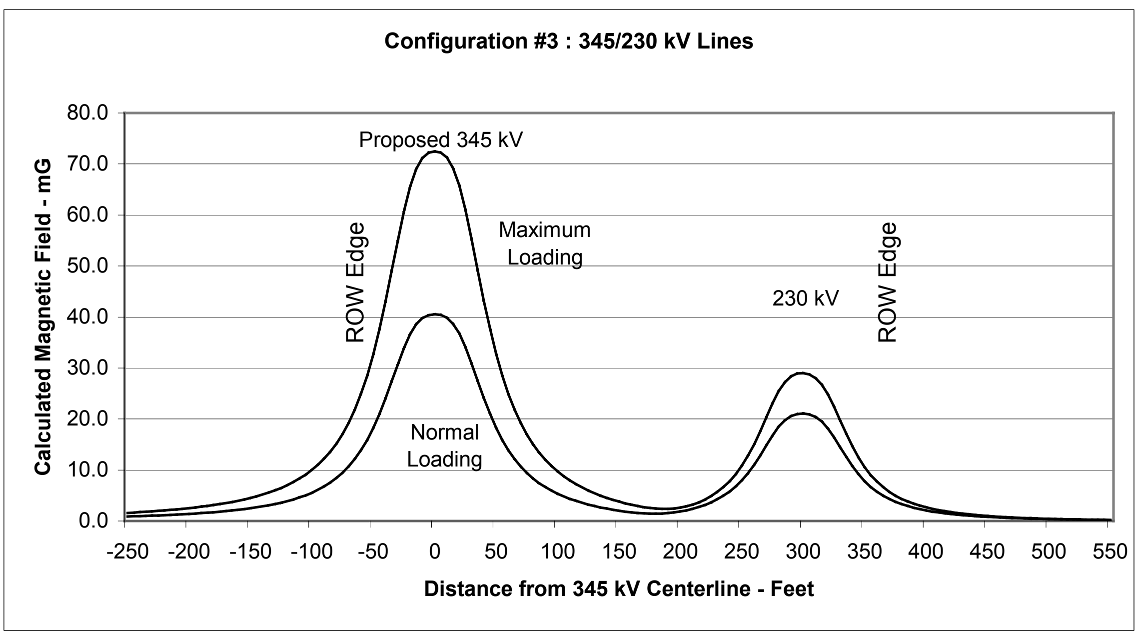


Table 3.10-10 summarizes the magnetic field calculations for the three transmission line configurations.

**TABLE 3.10-10: SUMMARY OF MAGNETIC FIELD CALCULATIONS FOR THE THREE TRANSMISSION LINE CONFIGURATIONS**

| CALCULATED MAGNETIC FIELD – MG | | | | | | | |
|---|---|---|---|---|---|---|---|
| Configuration Type and Loading Condition | ROW Edge | Maximum on ROW | ROW Edge | Max Near 345 kV | Max Near 66/25 kV | Max Near 120 kV | Max Near 230 kV |
| **# 1: 345kV Alone (Normal Load)** | 8.6 | 40.3 | 8.6 | 40.3 | | | |
| **#1: 345 kV Alone (Maximum Load)** | 15.4 | 72.1 | 15.4 | 72.1 | | | |
| **#2: 345 kV with 66/25/120 kV Lines (Normal Load)** | 8.5 | 40.4 | 6.9 | 40.4 | 8.8 | 17.6 | |
| **#2: 345 kV with 66/25/120 kV Lines (Maximum Load)** | 15.2 | 72.3 | 6.9 | 72.3 | 12.1 | 17.6 | |
| **#3: 345 kV with 230 kV Line (Normal Load)** | 8.4 | 40.5 | 5.3 | 40.5 | | | 21.1 |
| **#3: 345 kV with 230 kV Line (Maximum Load)** | 15.2 | 72.5 | 7.2 | 72.5 | | | 29.0 |

*Substation – Estimated Project Effects*
The magnetic field from substation equipment and buswork is typically low at locations beyond the substation property due to the placement of the equipment centrally within the station. Fields from substation equipment act as point sources and attenuate quickly with distance from the equipment. The dominant sources of magnetic fields near a substation are typically the overhead electrical transmission lines that enter and exit the substation. For the Falcon to Gonder 345 kV project, the addition of new transformers, buswork, reactors, circuit breakers, and other internal electrical equipment should not significantly impact magnetic field levels at locations outside of the substation. The dominant source of increased magnetic fields near the substation would be due to the proposed 345 kV transmission line itself.

***Induced Currents***
The proposed 345 kV transmission line would have the highest electric field within the right-of-way of approximately 4.5 kV/m in the area under the conductors at the lowest point of sag. Other locations on the right-of-way would be less. The electric field would be approximately 1.1 kV/m at the right-of-way edge. These fields are similar to many other 345 kV transmission lines currently in operation (and are generally less than the fields of operational 500 kV lines). Induced currents can be calculated for common objects for a set of theoretical (worst-case) assumptions: the object is perfectly insulated from ground, located in the highest field, and touched by a perfectly grounded person.

Calculations can be made using experimentally determined induction coefficients and the calculated electric field (EPRI 1982:356). Table 3.10-11 summarizes calculated induced current for common objects placed on the right-of-way for the theoretical conditions previously stated.

**TABLE 3.10-11: CALCULATED INDUCED CURRENT FOR OBJECTS NEAR 345 KV LINE FOR THEORETICAL CONDITIONS**

| Object | Length | Induced Current | Induced Current | |
|---|---|---|---|---|
| | | Coefficient- mA/ kV/m | Near Midspan | Right-of-way edge |
| Pickup Truck | 17 ft | 0.10 | 0.45 mA | 0.11 mA |
| Farm Tractor & /Wagon | 31 ft | 0.30 | 1.35 mA | 0.33 mA |
| Combine | 30 ft | 0.38 | 1.71 mA | 0.42 mA |
| School Bus | 34 ft | 0.39 | 1.76 mA | 0.43 mA |
| Tractor-trailer | 52 ft | 0.64 | 2.88 mA | 0.70 mA |

The maximum electric field only occurs on a small portion of the right-of-way, and perfect insulation and grounding states are not common, but for these assumptions the calculated induced current values for the pickup truck, farm tractor pulling crop wagon, school bus, and tractor-trailer are below hazardous levels where a person could not let go of an object (9 mA for men and 6 mA for women). Therefore, this transmission line would comply with the National Electrical Safety Code (NESC) requirements limiting induced currents on objects to 5 mA or less. At the right-of-way edge, the induced current values are near or below the threshold of perception. However, under the 345 kV line near midspan, the calculated induced currents on some of these objects are above the threshold of perception and for certain conditions may be perceived. The Falcon-Gonder transmission line would be designed to comply with the NESC.

Agricultural operations can occur on or near a transmission line right-of-way. Long fences parallel to a transmission line can present an induced current situation, especially if the fence posts are non-metallic and insulate wires from ground. This problem is solved by frequently grounding the fence with a ground rod connected to the fencing wire (usually done during transmission line construction). During project construction, SPPC would properly ground all metallic fences that parallel the transmission line for more than 500 feet and are located within 150 feet of the centerline. Grounding would also include large metal buildings and other metallic objects (personal communication with John Berdrow, SPPC, August 16, 2000).

Irrigation systems often incorporate long runs of metallic pipes that can be subject to field induction when located parallel and close to transmission lines. Because the irrigation pipes contact moist soil, electric field induction is generally negligible, but annoying currents could still be experienced from electric field coupling to the pipe. Pipe runs laid at right angles to the transmission line would minimize induced currents, although such a layout may not always be feasible. If there are induction problems, they can be mitigated by grounding and/or insulating the pipe runs. Operation of irrigation systems beneath transmission lines presents another safety concern. If the system uses a high-pressure nozzle to project a stream of water, the water may make contact with the energized transmission line conductor. Generally, the water stream consists of solid and broken portions. If the solid stream contacts an energized conductor, an electric current could flow down the water stream to someone contacting the high-pressure nozzle. Transmission line contact by the broken-up part of the water stream is unlikely to present any hazard. Guidance on safe operation of irrigation systems near transmission lines can be provided by electric utility engineers.

***Lightning***

Lightning has a tendency to strike tall objects. Any tall conducting object like a tree or a transmission line structure would have an increased probability of sustaining a lightning strike (Uman 1971). Concern is sometimes expressed that transmission lines are unsafe in electrical storms or somehow attract lightning. However, transmission lines do not “attract” lightning. Atmospheric electricity strikes the earth at locations where localized charge in a cloud and surface conditions cause a lightning stroke to occur. A lightning stroke usually hits the tallest object within the immediate area. A transmission line passing above the earth can be said to cast an "electrical shadow" on the land beneath it (EPRI 1982:547-548). Lightning strokes that would generally terminate on the land inside the shadow would strike the transmission line instead and strokes outside this shadow would miss the line entirely. If the transmission line were not present, some other object within the immediate area would still be struck by lightning.

Therefore, a transmission line actually protects the land near it from lightning, much as a lightning rod on top of a school protects the building beneath it. In the unlikely scenario where someone is outdoors during a lightning storm and simultaneously touching a transmission line structure, that person could receive a hazardous shock if the line were struck by lightning at that exact moment.

For objects less than 600 feet tall the strike probability is directly related to height (i.e., an object twice as tall as another object would generally have twice as many strikes), although object shape can be a factor too. For objects over about 600 feet tall, the likelihood of lightning strikes increases exponentially (Veimeister 1972:192-193). On a transmission line, the energized phase conductors are protected from lightning strikes by a shield wire(s) installed above the phase conductors. The shield wires of the Falcon to Gonder 345 kV transmission line are designed to intercept and safely conduct lightning to ground. The shield wires work similar to a lightning rod; when lightning strikes the shield wire, the electricity is conducted to earth through the structure which is grounded.

### *Pacemakers*

One area of concern related to the electric and magnetic fields of transmission lines has been the possibility of interference with cardiac pacemakers. Typically, electric and magnetic field levels at a transmission line right-of-way edge are usually below interference levels, but within the right-of-way the electric field threshold for interference may be exceeded. Interference can cause some pacemakers to switch from a normal full function pacing mode to an "asynchronous" fixed pace mode. Some new pacemaker models can be more sensitive to external interference, while other models appear unaffected.

There are two general types of pacemakers: asynchronous and synchronous (IITRI 1979). The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference because it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker, on the other hand, pulses only when its sensing circuitry determines that pacing is necessary. The concern is that interference could result from transmission line electric or magnetic fields, and cause a spurious signal in the pacemaker's sensing circuitry (Sastre 1997). However, when these pacemakers detect a spurious signal, such as an induced 60 Hz current, they are programmed to revert to an asynchronous or fixed pacing mode of operation and return to synchronous operation within a specified time after the signal is no longer detected. The issue for pacemakers is if transmission line fields could adversely affect their operation.

The potential for pacemaker interference due to high voltage transmission line fields depends on the manufacturer, model, and implantation method, among other factors. Studies have determined thresholds for interference of the most sensitive units to be about 2,000 to 12,000 mG for magnetic fields and about 1.5 to 2.0 kV/m for electric fields (University of Rochester 1985). The electric and magnetic fields at the right-of-way edge are below these values, but on the right-of-way the electric field threshold can be exceeded. The electric fields on the right-of-way are also above the limit value of 1 kV/m suggested for occupational exposure to electric fields (ACGIH 1999). It is unclear that reversion to a fixed pacing mode is harmful since pacemakers are routinely put into reversion with a magnet to test operation and battery life. Some new pacemaker models are dual chamber devices that can be more sensitive to external interference. Some of these dual chamber units may experience inappropriate pacing behavior (prior to reversion to fixed pacing mode) in electric fields as low as 1.2-2 kV/m, while other models appear unaffected in fields up to 20 kV/m.

The biological consequences of brief, reversible pacemaker malfunction are mostly benign. An exception would be an individual who has a sensitive pacer and is completely dependent on it for maintaining all cardiac rhythms. For such an individual, a malfunction that compromised pacemaker output or prevented the unit from reverting to the fixed pacing mode, even brief periods of interference, could be life-threatening (Sastre 1997:8-2). The precise coincidence of events (i.e., pacer model, field characteristics, and biological need for full function pacing) would generally appear to be a rare event.

### Human Health Studies and Electric and Magnetic Field Standards

There has been public concern over the potential for exposure to EMF to adversely affect human health. The consensus among the medical and scientific communities is that there is insufficient evidence to conclude that EMF causes adverse health effects. Neither the medical nor scientific communities have been able to provide any foundation upon which federal or state regulatory bodies could establish a standard or limit for exposure that is known to be either safe or harmful. The Falcon to Gonder project would produce electric and magnetic fields that are typical of other similar transmission lines already in operation (with similar line design, loading, and voltage classification characteristics). However, there are no federal or state standards related to the human health effects from electric and magnetic fields to serve as a basis for determining a level of impact.

There are no EMF standards for the state of Nevada for transmission line fields. However, a number of other states have set some type of electric or magnetic field limit. In addition, other organizations have established field exposure standards or guidelines. Existing EMF guidelines or limits are summarized in Tables 3.10-6 through 3.10-8. The calculated electric field of 1.15 kV/m at the right-of-way edge and 4.55 kV/m maximum within the right-of-way for the proposed Falcon to Gonder 345 kV transmission line would comply with most existing standards from other states. The calculated magnetic field of 15.4 mG at the right-of-way edge (under maximum loading) for the proposed Falcon to Gonder 345 kV transmission line would comply with other state standards. Both calculated electric and magnetic field levels are well below the guidelines established by the American Conference of Governmental Industrial Hygienists (1999) and the International Commission on Non-Ionizing Radiation Protection (1998).

### Corona

Because power loss is uneconomical and noise is undesirable, corona on transmission lines has been studied by engineers since the early part of this century. Many excellent references exist on the subject of transmission line corona (e.g., EPRI 1982). Consequently, corona is well understood by engineers and steps to minimize it are one of the major factors in transmission line design. Corona is a design consideration for transmission lines rated at 345 kV and higher. A corona design feature of the proposed 345 kV transmission line is the use of large-diameter bundled subconductors and corona rings at hardware attachment points, which lower the electrical stress on the air at the conductor surface so that corona activity is at low levels under most operating conditions.

❑ ***Impact Public Health and Safety-5: Potential EMF and Electrical Effects from Transmission Line***

The Falcon-Gonder 345 kV transmission line would be designed to comply with the National Electrical Safety Code. Therefore, the project should not create significant or unusual impacts in areas such as electric and magnetic fields, corona, fuel ignition, fires, lightning, or visible light. Therefore, no special mitigation is required.

The electric and magnetic field levels found under normally operating high voltage lines, including the proposed 345 kV transmission line, do not produce adverse effects in livestock or wildlife, and no significant adverse effects on plants or crops have been identified. The transmission line would comply with NESC requirements limiting induced currents on objects to 5 mA or less. SPPC would properly ground all metallic fences that parallel the proposed transmission line for more than 500 feet and are located within 150 feet of the centerline. Grounding would also include large metal buildings and other types of objects.

The shield wires of the proposed Falcon-Gonder 345 kV transmission line are designed to intercept and safely conduct lightning to ground. Therefore, the transmission line would actually protect the area near it from lightning. In the unlikely scenario where someone was outdoors during a lightning storm and was simultaneously touching a transmission line structure at the exact moment of a lightning strike to a tower, the person may receive a hazardous shock.

There are no EMF standards for the state of Nevada for transmission line fields. The calculated electric and magnetic field at the right-of-way edge and within the right-of-way would comply with most existing standards from other states, and are well below the guidelines established by the ACGIH and the ICNIRP (see Tables 3.10-6 through 3.10-8). The consensus among the medical and scientific communities is that there is insufficient evidence to conclude that EMF causes adverse health effects. There are no federal or state standards related to the human health effects from electric and magnetic fields to serve as a basis for determining a level of impact.

The potential for pacemaker interference from transmission line fields depends on the manufacturer, model, and implantation method, among other factors. For individuals with pacemakers or similar implanted medical devices, the electric and magnetic fields at the right-of-way edge are below typical interference values, but on the right-of-way the electric field interference threshold can be exceeded; they are also above the limit value of 1 kV/m suggested for occupational exposure to electric fields (ACGIH 1999). Some new pacemaker models are dual chamber devices that can be more sensitive to external interference and may experience inappropriate pacing behavior. The biological consequences of brief, reversible pacemaker malfunction are mostly benign. An exception would be an individual who has a sensitive pacer and is completely dependent on it for maintaining all cardiac rhythms. For such an individual, a malfunction that compromised pacemaker output or prevented the unit from reverting to the fixed pacing mode, even brief periods of interference, could be life-threatening (Sastre 1997:8-2). The precise coincidence of events (i.e., pacer model, field characteristics, biological need for full function pacing) would generally appear to be a rare event.

A significant amount of research has been done on electric and magnetic field mitigation options (Silva 1999). For the electric and magnetic field effects from the proposed 345 kV transmission line, mitigation efforts could include: wider right-of-way, taller structures, delta (triangular) phase configuration or passive shielding. However, these measures may not be necessary for the project and are not recommended at this time.

## Alternative-Specific Impacts

Potential project impacts related to fire management, hazardous materials, and electric and magnetic fields would be essentially the same for all of the route alternatives. There are no additional alternative-specific impacts.

## Summary Comparison of Route Alternatives

**TABLE 3.10-12: SUMMARY OF IMPACTS BY ROUTE ALTERNATIVE**

| Impact | Crescent Valley (a) | Crescent Valley (b) | Pine Valley (a) | Pine Valley (b) | BUCK MOUNTAIN |
|---|---|---|---|---|---|
| Impact Health and Safety-1: Potential Fire Hazards Related to Construction, Operation and Maintenance | X | X | X | X | X |
| Impact Health and Safety-2: Potential Fire Hazard from Energized Transmission Line | X | X | X | X | X |
| Impact Health and Safety-3: Potential Fire Hazards Related to Cheatgrass | X | X | X | X | X |
| Impact Health and Safety-4: Potential Health and Safety Impacts from Hazardous Materials | X | X | X | X | X |
| Impact Health and Safety-5: Potential EMF and Electrical Effects from Transmission Line | X | X | X | X | X |

## RESIDUAL IMPACTS

Discussion of residual fire impacts related to ground disturbance, vegetation and cheatgrass is contained in Section 3.4, Vegetation. No significant residual public health and safety impacts are anticipated.

## NO ACTION ALTERNATIVE

Under the No Action Alternative, potential public health and safety impacts associated with this project would not occur. However, similar impacts could occur in other areas as SPPC and the Nevada PUC would begin emergency planning efforts to pursue other transmission and/or generation projects to meet the projected energy load capacity shortfall.